Space Weather Technical Forecast

Issued on Sunday, 22 May 2022 at 01:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1-R2 Radio Blackouts likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low over the past 24 hours, the background flux remaining in the C-class range with only minor isolated flares.

There are currently up to eight sunspot regions on the disc, seven of which are numbered. By far the largest and most complex remains AR3014, which remains an Ekc/BGD and has shown growth in its intermediate penumbra and spots. The delta spot remains in its central portion. Also of note was a new region arriving over the southeastern limb as an Hsx; and AR3017, which continued to show the development of numerous small spots, mainly in its leading portion which led to its span exceeding 10 degrees to become an Eai/Beta. All other groups showed eventual decaying trends, with no significant flares. No Earth-directed CMEs were observed in available imagery in the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar wind speeds, as measured by ACE and DSCOVR at L1, slowly decreased from 550 to 460 km/s during the last 24 hours, under the waning influence of coronal hole 82. The solar wind density was below average, along with a weak Interplanetary Magnetic Field (IMF). The north-south component, Bz, oscillated between -5nT and +4nT but remained negative for long periods at times. The phi angle was largely positive (away from the sun). The net result of the above solar wind measures was provisionally Quiet to Unsettled.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) has been at Background levels through the last 24 hours.

The high energy electron flux (greater than 2 MeV) rose to Moderate levels, peaking at 931 ppcc at 21/1655 UTC, as a result of the fast wind from CH82/+. The corresponding electron fluence remained well below the Active threshold (1e8 integrated pfu) but rose sharply during the second half of the period, reaching 2.4e7 integrated pfu at 22/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Likely to be Moderate, with a chance of M flares (R1-R2 radio blackout) at times, mostly from AR3014 but also perhaps from AR3017 given its recent growth. A large CME has been observed leaving the far side of the sun earlier, indicating the presence of one or more active regions. This is also confirmed by bright flux regions visible on STEREO A EUVI195 imagery. These will need to be closely monitored over the next few days, as they gradually emerge on to the eastern limb

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are currently expected. Solar winds are now under the waning influence of coronal hole 82 and expected to come back to ambient levels over the following days. They might become slightly enhanced on day 3 (24th) but any impact on the geomagnetic conditions should remain minor and brief. Geomagnetic

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

activity is expected to be mostly Quiet with a few Unsettled periods.

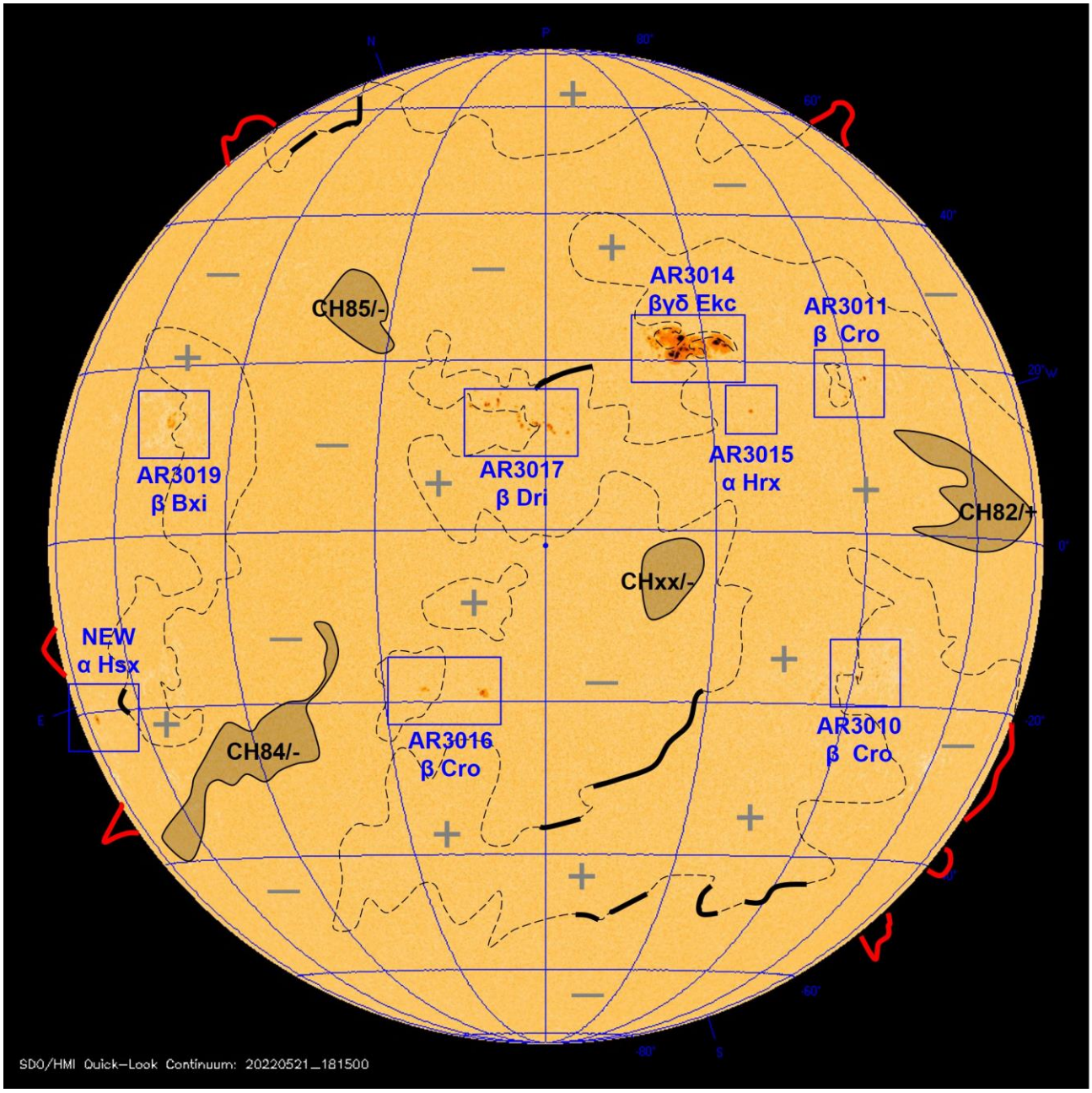
Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to be at Background levels during this period, but with a daily Slight Chance of flux reaching S1, should any notable flares occur.

The high energy electron flux (greater than 2 MeV) is forecast to fluctuate between Low and Moderate levels, perhaps exceeding 1000 pfu during the diurnal peak at times. The 24-hour electron fluence will most likely remain below the Active (1e8 integrated pfu) threshold during the forecast period, albeit with a rising trend.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 1. Solar Analysis Valid 21/1800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

A few CMEs were observed on satellite imagery in the last 24 hours but their analysis revealed that none of them are Earth-directed.

The current fast speed stream emanating from CH82/+ is on the decline, with speeds now slightly elevated and continuously decreasing. With no other significant coronal features on the western hemisphere, solar winds should continue to decline and come back to slow-ambient levels. A small negative coronal hole may have developed near the solar equator but the proximity of two sunspot regions nearby is making the assessment difficult. However it seems benign and therefore unlikely to cause any significant impacts on the geomagnetic activity. The other coronal holes visible on the Earth-facing disc, namely CH84/- and CH85/-, are further east and their respective fast speed streams not expected to become geoeffective during this period.

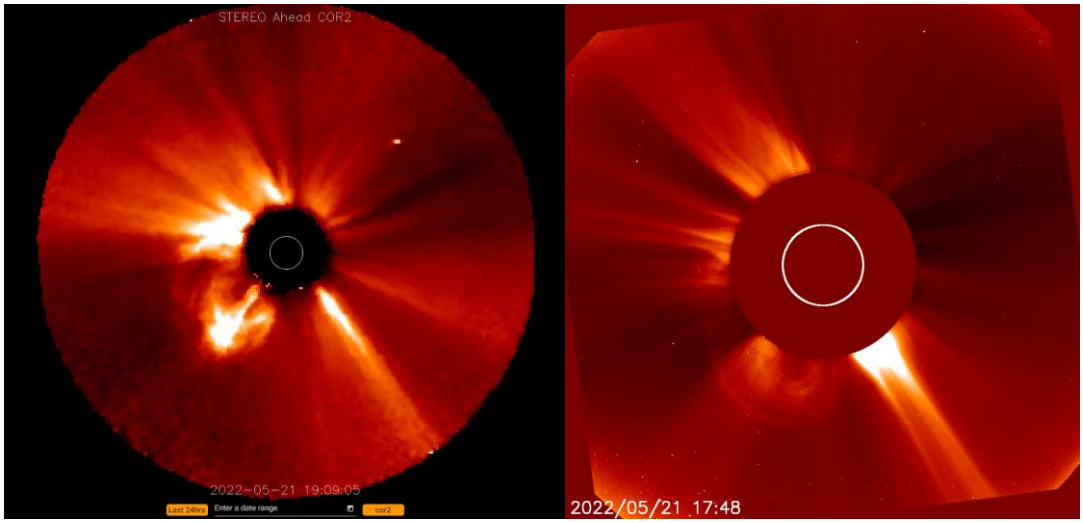
With the above in mind, geomagnetic activity is expected to be mostly Quiet with a few Unsettled periods.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity – Earthbound Coronal Mass Ejections

NIL.

Figure 2: Stereo A (left) and Lasco (right) imagery, showing a CME emerging from the south-eastern limb of the sun



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

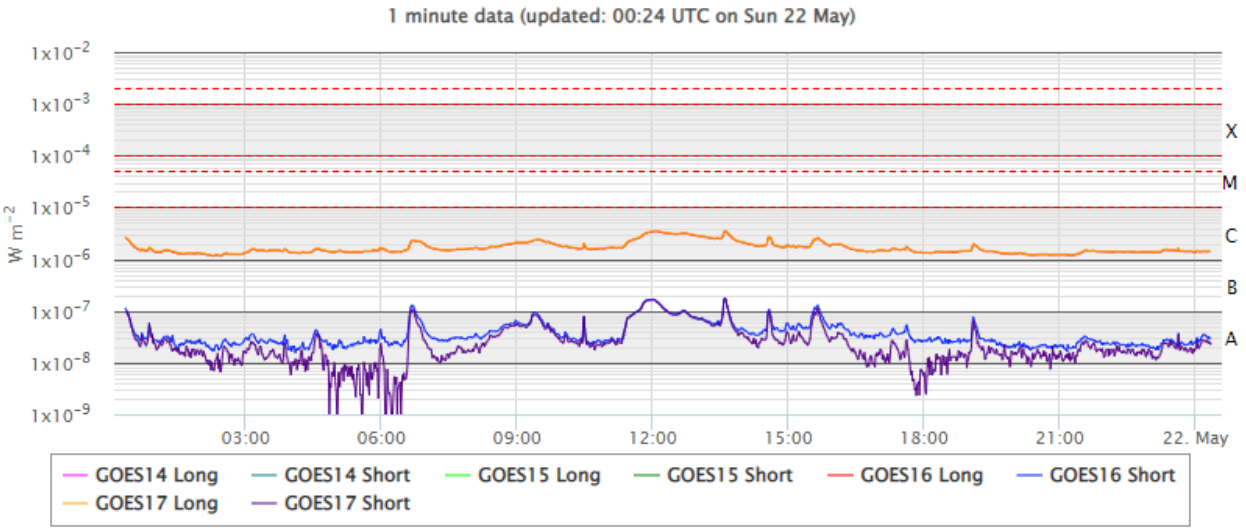
Radio Blackouts - X-Ray Flares:
There are now up to eight sunspot regions on the Earth-facing disc. By far the largest and most complex remains AR3014, which remains an Ekc/BGD and has shown growth in its intermediate penumbra and spots. The delta spot remains in its central portion. Also of note was a new region arriving over the southeastern limb as an Hsx; and AR3017, which continued to show the development of numerous small spots, mainly in its leading portion which led to its span exceeding 10 degrees to become an Eai/Beta. All other groups showed eventual decaying trends, with no significant flares.

Solar activity has been Low in the last 24 hours. Despite the size of AR3014 and its complexity, it is currently undergoing a quiet spell, however, M-flares (R1-R2 Blackout) are still considered Likely. AR3017 remains a group to watch given its growth trend.

A large CME has been observed leaving the far side of the sun earlier, indicating the presence of one or more active regions. This is also confirmed by bright flux regions visible on STEREO A EUVI195 imagery. These will need to be closely monitored over the next few days, as they gradually emerge on to the eastern limb. A couple of large filaments currently on the western hemisphere. Any lift-off could potentially be Earth-directed.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

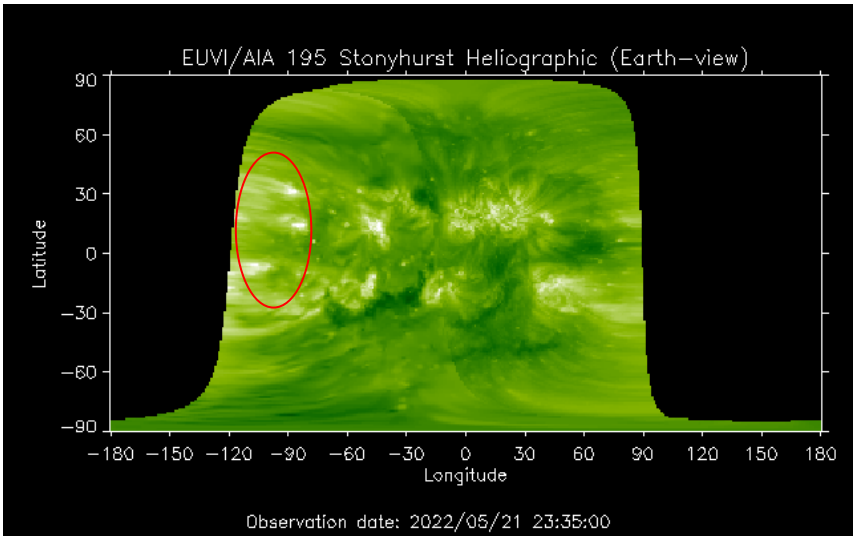
Figure 3: GOES X-ray flux showing a C-class range background



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 4: SDO EUVI/AIA 195 imagery showing a bright flux region (red circle) around 90-120 degrees east.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is at background levels and is most likely to remain at that level through the period.

The daily risk of surpassing S1 should very slightly increase over the four-day period, although the raw probability is close to 10% throughout and that figure is therefore used throughout. This risk is the result of the westward progress of the largest and nominally most complex region on the disc, although despite some M-class activity, this has not yet proven to have delivered any proton enhancement at Earth.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

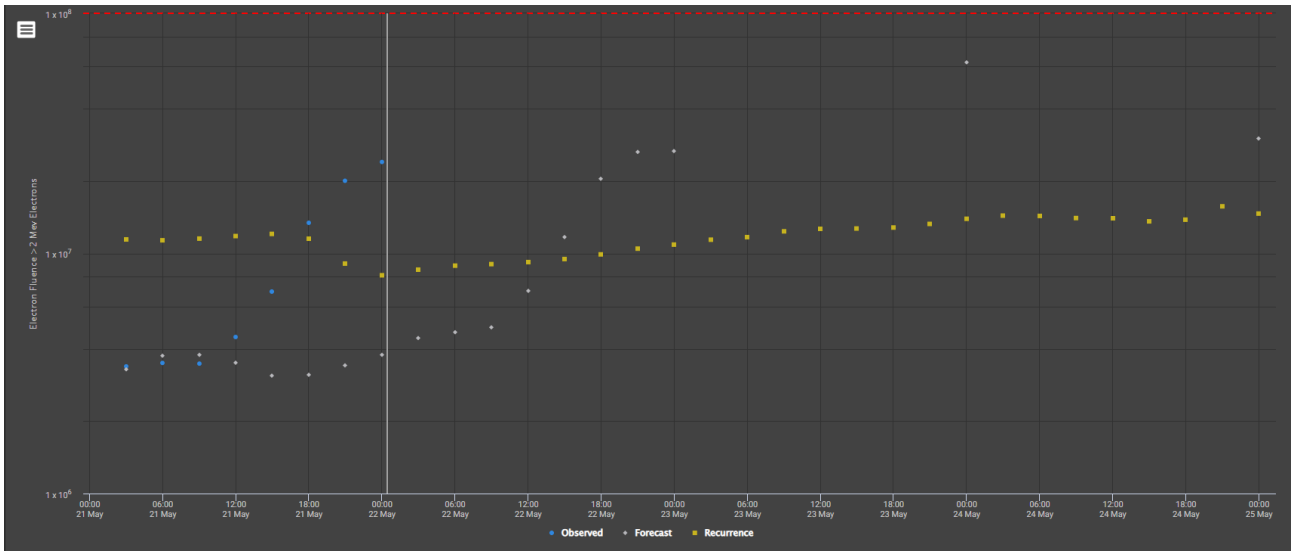
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2 MeV) rose to Moderate levels, peaking at 931 ppcc at 21/1655 UTC, as a result of the fast wind from CH82/+ charging the radiation belts. It is expected to fluctuate between Low and Moderate levels over the next few days, perhaps exceeding 1000 pfu during the diurnal peak at times. On the previous rotation, the fast solar wind regime proved incapable of resulting in Active 24-hour integrated electron fluence. The current solar wind enhancement from CH82/+ is slightly enhanced in comparison, so while flux may increasingly trouble the High boundary, on balance it should most likely average out below Active 24-hour fluence, even as CH82/+ and its resultant geomagnetic activity wane into the forthcoming working week.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	30	20	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: Latest REFM output



NOTE: Our REFM model has been upgraded and has changed in appearance. The two main changes are the option to include a recurrence graph, which traces what happened on during last solar rotation for comparison and potential expectation in the coming 3 days (each plot is the observation from T-minus 28 days). Also, the cadence of REFM forecast fluence data is reduced past day 1 to only one value per day. The cadence remains 3-hourly for the first 24 hours.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.